

**Final Report
Program Review of Ecosystem Science
NMFS Office of Science & Technology**

Silver Spring Civic Center
1 Veterans Plaza
Silver Spring, MD 20910

July 26-29, 2016

Chair's Summary

Review Panel Members

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Summary of Report Structure

The Chair's summary report provides a brief introduction to the purpose of the review, an overview of the meeting proceedings, general observations about the six programs of the National Marine Fisheries Service (NMFS) Office of Science and Technology's (OST) Ecosystem Science, brief summary of panel member's recurrent observations and recommendations with respect to a set of questions posed in the Terms of Reference for the review. As Chair I elected not to submit a separate report and instead rely on Panel Member reports. The views expressed in this Chair's Report are my own and any errors or omissions are mine alone. Panel Member reports are also included to provide additional detail and insights that may not be adequately captured in this summary.

Background and Overview of Meeting

This year (2016) Ecosystem Science was reviewed as part of the ongoing six-year cycle of reviews of science programs in NMFS. This review of Ecosystem Science includes reviews of the six individual NMFS science centers as well as OST Ecosystem Science. The OST Ecosystem Science review focuses on the following elements/programs:

Integrated Ecosystem Assessments [IEA]
Fisheries and the Environment [FATE]
Marine Ecosystems and Climate
Habitat Science
Coastal & Oceanic Plankton Ecology, Production, & Observation Database (COPEPOD)
Ecosystem Modelling Coordination

These elements meet the definition of OST Ecosystem Science selected for panel review: i.e., "as those elucidating ecological, oceanographic, climate and habitat related processes as they are related to living marine resource (LMR) species. In addition, these reviews will assess the extent to which current science programs are focused on the priority information needs required to complete the NMFS mission. Ecosystem-related science programs addressed in these reviews may include science programs that support ecosystem-based management of fisheries and protected resources; conservation and restoration of habitats; dynamics of ecosystem and LMR productivity; ecosystem-level responses to pressures; understanding the effects of pressures on food webs and the effects of food webs on LMRs; oceanographic effects on LMRs; and understanding of climate-related forcing and impacts on the LMRs." While there are other habitat and climate related programs in NMFS and the National Oceanic and Atmospheric Administration (NOAA) the panel purview is limited to the above elements/programs.

Overview of Meeting Proceedings

Following the formation of review panel membership the draft agenda was circulated for purposes of informing the participants of what to expect. Panel members were encouraged to contact OST leadership with any questions. Two weeks prior to the face-to-face meeting July 26-29, 2016, all meeting materials were posted on the OST website. These materials were keyed to the final agenda. They were also available in a downloadable zip.file format as well as hard copy on request. Additional materials were provided on request of the panel during the meeting. In addition, a questionnaire was sent from OST to each science center requesting regional comment on each of the Ecosystem Science programs from the perspective of OST's national coordination. The questionnaire also requested suggestions from the Science Centers on what was needed to improve coordination and advance ecosystem science.

The kick-off for the review was a dinner the evening of July 25 where panel members had a chance to meet each other as well as OST leadership. This dinner afforded the opportunity to review the intent and organization of the meeting and to answer any final questions. The tenor of the meeting starting on July 26 was a mix of formal presentations followed by Q&A. In addition, an informal post meeting reception was held where multiple conversations were had that provided useful context for the Panel Members in talking with those attending. On July 27 presentations continued during the morning and early afternoon. Panel Members were accorded time to meet privately each day to review progress, identify any outstanding issues and to share observations. The Panel Members indicated a number of times that they were available to talk with any of the attendees about ideas and insights that might be given in one-on-one discussions. As Chair, I observed that this resulted in a number of side discussions at lunch, breakfast and during breaks. The Panel also set aside some of its private time to offer anyone so inclined to meet separately with the full Panel. One individual took advantage of this opportunity.

The late afternoon of July 27 was devoted to Panel discussion and planning for writing Panel Member reports. July 28 was devoted to the Panel Members drafting their reports and this included the opportunity to revisit issues with presenters in mid-morning. This helped to clarify and to ensure that Panel Members properly understood certain issues. July 29 the Panel Members reported their preliminary observations and recommendations to NMFS and OST leadership. Panel Members supplied their final reports to the Chair over the ensuing week.

Besides the review panel members, the review was attended in part or whole by Assistant Administrator of NMFS Eileen Sobock, NMFS Chief Scientist Richard Merrick, NMFS Chief Ecologist Jason Link, as well as OST leadership Ned Cyr, David Detlor, and Kenric Osgood, Stephanie Oakes and many OST staff members. A full listing of presenters is available in the agenda. Rita Curtis graciously joined the review upon the Panel request for additional information on socio-economics [human dimensions] of ecosystem science in OST. All preparations and site management was ably provided by Emma Kelley OST and Katherine Slater (NOAA Affiliate).

General Observations

The Panel Members were very favorably impressed with the overall efforts of NMFS OST to contribute to NMFS and NOAA ecosystem science. The Panel Members note that NOAA and particularly NOAA fisheries have fully subscribed to implementing Ecosystem Based Management (EBM) and Ecosystem Based Fishery Management (EBFM) with the development of the EBFM Policy and Draft Roadmap. NMFS presentations indicate that implementation is a work in progress and Panel Members would agree. The Marine Ecosystem Division (MED) of Office of Science and Technology plays both lead and support roles in this enterprise within NMFS with the six program areas under review. Review of the ecosystem science programs under the MED is made difficult because of the way the MED serves these two roles and is deeply embedded in NMFS but also serves a broader role in NOAA. Thus it is difficult at times to separate out what is the contribution of the "programs" sitting in OST but engaging across NMFS, other NOAA line offices (LO) and with external partners. While this can be seen as a challenge it also demonstrates the integration of MED programs into NMFS and other NOAA missions.

As the review panel learned, OST is a complex organization that serves multiple purposes in NOAA Fisheries and NOAA more generally. Looking across OST and its six Divisions, each with quite different functions, one realizes that it is more of a conglomerate than a conventional NOAA line office. The history for how OST accreted these functions is a necessary backstory to the review being conducted because many of the functions directly or indirectly can be seen to support ecosystem science even though that is not the principal function, e.g., the Observer Program gathering data used in stock assessment and bycatch reduction programs and testing new observing technologies. If

one looks at the OST Strategic Plan 2013-2018 there is an overriding goal for the OST, “to lead and support the production, delivery and use of ecosystem information to fulfill the agency’s mandates.” For the ecosystem activities goal it is, “Lead and coordinate science support to national and regional programs engaged in assessment of living marine resources, including managed fish stocks, protected resources and marine ecosystems and habitats”. There are more explicit goals for the programs under review. Unfortunately the overarching goal does not connect the individual programs very well and is largely aspirational as opposed to practical given its limited resources and authority. Implicitly OST strives for scientific excellence and administrative efficiency in program management. OST program priorities are set in what seems to be a negotiation between OST and NOAA Fisheries mandates, science boards, science centers, councils, fisheries priorities, annual guidance memoranda, etc. Again, this complexity for OST MED demonstrates its integration within NMFS and other NOAA line offices and can be largely regarded as an advantage of being embedded in NMFS.

What appears to result, as one might expect when trying to do seamless ecosystem science, it is sometimes difficult to define boundaries of where one program stops and others begin. While it appears that there is good communication among the OST program leaders and agreement to avoid overlaps it is hard to communicate this understanding more broadly. Without putting too much weight on the responses to the OST Questionnaire from Science Centers there seemed to be some variation in understanding of OST’s roles in ecosystem science. Certainly some of this variability turns on who filled in the Questionnaire and that person’s familiarity with each program despite efforts by OST to provide helpful description of each of the programs with the Science Centers.

The Panel Members themselves struggled to fully understand the multiple roles of OST MED programs vis a vis the Science Centers and others within NMFS as well as other NOAA line offices. Thanks to the explanations received from OST MED leadership and staff I think that we got much closer to understanding the relationships that exist. I would point out that some of this back and forth was sparked by concerns of Panel Members about the role of human dimensions sciences in OST’s ecosystem sciences and why it was not included more formally in the review other than with respect to IEAs. It seems that because Human Dimensions /Socio-Economic sciences are to be reviewed in the coming year that it was not specifically brought into this Ecosystem Science program review. This need to focus the review is not unique to this review based on my read of the Stock Assessment review and the Habitat/Protected Species reviews as well. Because NMFS and NOAA are moving to make scientific advice to management more ecosystem-based there is a need to forge a common understanding of the way various programs fit together.

In order to assist OST MED cope with its need to communicate clearly to the NMFS Science Centers and to NOAA and external parties more broadly, Panel Members offered a number of suggestions that I would boil down into a recommendation that the specific roles (e.g., coordination, support, leadership, convening, etc.) performed by OST for NMFS and within NOAA ecosystem be identified for each program and that the relationships among OST programs is indicated. The goal would be a short formal statement [kept up to date] with respect to OST ecosystem science programs that could be posted on the website and then specific elements repeated within each program description. It is not easily done given the roles and functions that are brought together in the MED collection of programs. Thus, an alternative for OST is to develop a science plan that states a general goal and identifies individual program objectives and then, to the extent possible attempts to connect the individual programs. The issue with this is the likelihood that because these programs have not been designed to be coherent they may best perform separately.

More importantly, perhaps, is the question of OST’s MED role in NMFS and NOAA ecosystem science. Clearly, it performs a number of useful functions and does an excellent job in so doing. However, it seems that these functions are assigned to OST as opposed to OST having the opportunity to define its roles more coherently. Obviously, this is a two way street that had to be resolved at higher levels within NMFS and NOAA. I would emphasize that the Panel Members are not trying to criticize the performance of the OST MED in the status quo but asking if ecosystem science for NMFS and NOAA could better be advanced with more resources and autonomy. Arguments can be made either way because OST MED has demonstrated its ability to leverage resources from other parts of NMFS and NOAA by providing invaluable services to link with other programs and having more autonomy may decrease the buy in to programs although having resources to distribute is also shown to provide incentives to cooperate and collaborate. This theme continues through the remainder of the review.

Next I briefly summarize Panel Member overall responses to the six programs scheduled for this review. The Panel Members were universally complimentary to the Strategic Plans prepared for these programs as well as the science products being generated and encouraged that the Habitat Assessment Improvement Plan (2010) plan be revised. Specifics are found in their reports.

IEA. Integrated Ecosystem Assessment program is performing above its weight in terms of resources. OST MED has kept the program vibrant and striving to earn respect for its contributions to ecosystem science in the Science Centers and Councils. This is happening but IEAs are not just about fisheries, they are the needed at the core of ecosystem science relative to NOAA's other missions. IEAs engage with regional marine spatial planning and are critical to the evolution of EBM across NOAA and its partners. However it appears that IEAs cannot live up to their full potential and utility without broader engagement with fisheries and especially with other NOAA missions. As pointed out by several Panel Members, the funding for IEAs comes out of stock assessment (EASA) funds which they consider is important because of IEA contribution to that function but more funding and other sources need to be tapped.

FATE. Fishing and the Environment is seen as a very strong program that has fostered advances in ecosystem science and has made documented contributions to the application of science to the management processes. The Panel Members would like to see the program expanded in scope and geographically. One Panel Member pointed out that FATE lacks a complementary focus in the academic community and suggests possible collaboration between FATE and the academic community to develop the next generation of GLOBEC or CAMEO-style project. A point was made in discussion and by several Panel Members that the 2-year funding [and timing of the release of the funding presented problems for which a better solution should be sought.]

Climate. Climate is seen as a strong contributor to ecosystem science. As noted above some Panel Members felt that the program should include a strong social science component because how humans are affected by climate change and influences on commercial and recreational fisheries distribution and abundance is what is important to management. Here as well, Panel Members felt it useful to expand the scope and geographic coverage for this program. The climate vulnerability assessment program is a "great" initiative.

Habitat. Panel Members pointed out that Habitat was not actually part of OST's MED but was being reviewed. There was a fair amount of discussion about the Habitat program with respect to its size, how it conducts its RFP process, and where it belongs in OST. While Panel Members acknowledged that it has produced valuable research and its competitive nature generated a fair amount of interests, they also questioned whether it was too small to be administratively efficient, if there should be ways to operate the competitive RFPs so that multi-year larger projects could be funded and if the RFP should be more specific by designating focus areas as opposed to being wide-open. As chair, my take on this says that the discussion and the differing points of view provide a thought-provoking starting place for discussions in OST with no clearly superior options on the table.

COPEPOD. COPEPOD was recognized as a well-respected global plankton database and one that should continue to develop. Concerns were expressed about the need to keep up with other emerging plankton databases using other technologies [genomics]. The potential for a plankton database to become more important in EBFM and IEAs was also recognized. Although the reason COPEPOD was among the MED programs was explained to the Panel there seemed to be reluctance to endorse that location over the long term where integration of databases at the regional, national and international levels appears to be the trend.

Ecosystem Modelling Coordination. The Panel Members generally agreed that this new [1-year old] program was an important initiative. It builds off a series of three modelling workshops that were well-received. The dual role of encouraging the development and use of models in fisheries management was ambitious and there was unresolved discussion among the Panelists about what the priority should be, i.e., development of tools, standardization of models for use in management or outlining best practices in modelling and scenarios. The importance of modelling in assessing trade-offs in management given scientific uncertainties was also mentioned.

Panel Member's Major Recurrent Observations and Recommendations

In this section I try to capture the important take away messages the Panelist have made in their individual reports. This is not a consensus-based report. It represents what I consider to be the primary observations and

recommendations obtained from the reviewer reports. Given the diverse experience and perspectives of each Panelist I have tried to capture the richness of the ideas to offer to OST MED in its quest for continued performance improvements. I believe it safe to say that one thing upon which the Panel did agree was that it is our task to provide our best individual advice to a complex set of programs and to a very dedicated and competent OST MED enterprise attempting to accomplish a set of huge tasks. A second area of agreement is there are more resources needed in every program in OST MED. That goes without saying so I will not repeat it as often as Panel Members made that appeal. OST MED programs do a remarkable job of leveraging resources and until budget fortunes change more must be done in that dimension to accomplish goals.

The OST MED review Panel Members were given the following five headings around which to garner responses with respect to Panel Member observations and recommendations. Because Panel Member reports all differ somewhat from this format I have read between lines and interpolated quite a bit. Some of these observations and recommendations are redundant to those stated above.

• **Goals and objectives**

- Observations
Panel Members basically reported that they found the explicit goals and objectives for individual programs in this review were reasonably good. What they felt was lacking was a strong connection to the overarching goal of OST and MED specifically across programs (see these goals quoted above). In some senses these goals match up inspirationally but not very practically to produce a comprehensive ecosystem science goal. This may be asking a lot for the ways that ecosystem science tasks are assigned to OST and how MED in collaboration across NMFS and NOAA more broadly is expected to carry them out. Because of this process of accretion of program tasks MED is not in a position to design the leadership and support program it administers. By coordination among programs at the MED level it appears that programs are made marginally more coherent and synergies are captured.
- Recommendations to address issue
Two general approaches are recommended toward addressing this apparent mismatch of goals and objectives between the MED overarching goal and the goals of existing programs. One approach is revising the overarching goal to connect with the individual programs. The second approach is to treat the programs as separate and restate a more limited MED goal of excellence in program design and administration. A third approach that would give OST MED a stronger role in program design would depend on decisions made at a higher level in NMFS and NOAA.

• **Integration with relevant programs**

- Observations
Overall integration of OST MED programs with other relevant programs within NMFS is extremely strong and some programs like IEA and Climate are leveraging a lot of work from other line offices. Most are already cross-cutting programs. With other NOAA line offices there are consistent and substantial efforts by OST staff to maintain contacts and to engage with others but this enterprise necessarily is less robust than within NMFS. Opportunities should continue to be explored. As seen from Science Center responses to the OST Questionnaire there may be a need to clarify the links to regional processes by OST. The lack of inclusion of socio-economic programs in this review was seen by several Panelists a flaw across all programs as an opportunity for greater attention. Once the sidebars for this Ecosystem Science review were described and assurances made that work was being carried out there was grudging acceptance that such review would take place next year.

Habitat science is part of the review but not under MED.

COPEPOD seems to be an isolated or orphan program within OST.

- Recommendations to address issues

Produce a short document to be circulated and posted on the OST webpages that identify the program, state who is involved, and list the products from the program. Concomitantly state how programs are interconnected if that is the case.

Further integration to consider would be to allow the development of project that could be funded across more than one program and advertise the opportunity.

Consider relocating Habitat program in MED.

COPEPOD has potential links to other programs, e.g., IEA, FATE and Climate if primary production were to take a greater role in assessments leading to management advice.

• Address priority needs

- Observations
In general there seems to be strong commitment towards NMFS and NOAA mandates and alignment with the top priorities. One reviewer indicates there may be an imbalance between ecosystem science for fisheries management in comparison to protected species or marine biodiversity and calls for science for conservation policy as well as a broader visioning for what constitutes a healthy ecosystem. Based on my review of the Chair's report for Protected Species and Habitats last year, this concern was at least partially addressed then. Two other reviewers seem at odds with each other with respect to the documentation of ecosystem science to management in the FATE program with one maintaining there is good documentation and the other asking that better documentation be developed. One reviewer cites the Habitat program as too narrowly focused on coastal and not open ocean science. Several reviewers would like to see FATE expanded in scope and geographically.
- Recommendations to address issue
In response to the need to balance science for management and science for biological conservation it may be useful to review the findings and recommendations from last year's review. When OST MED looks at the balance of investments, one reviewer suggests bringing in other participants from outside NOAA to inform that review.

It may be useful to revisit the question of FATE as well as other programs in terms of documenting whether the science produced being used in management decisions for fisheries or for biological conservation.

The habitat science program is clearly important for NOAA. One reviewer suggests that the RFP for habitat science be directed at the science needed for the revision of the Habitat Assessment Improvement Plan.

• Communication of status and accomplishments

- Observations
In the section above on Goals and Objectives one type of communication need was discussed that is separate from the intent of this section.

There seems to be general agreement that communication of status and accomplishments of OST MED programs is at least adequate and most often excellent. Communication tends to focus on the products developed in each region and not as much attention is given at the national level in terms of communicating regional results. Panelists drew attention to publications they thought were outstanding.
- Recommendations to address issue
One Panelist recommended that OST MED develop a greater web presence for regional efforts to communicate program results. My review of the OST website indicates rather uneven treatment of regional program results. Habitat seems to be the most replete but still not comprehensive whereas IEA provides a decent description of the program but limited links to ongoing regional efforts. This would facilitate sharing of experience and methods.

Several panelists encouraged continued efforts by IEA, Climate and Habitat programs to engage with fishery management councils and other agencies to show the relevance and value of their work for management

• **Other**

○ Observations

A diverse set of responses was supplied by Panelists with respect to this “other” category. One Panelist did make comments; another Panelist drew attention to the National Estuarine Assessment missing Alaska and Hawaii which account for a substantial portion of the US coastline. A third Panelist provides a somewhat extended observation on fiscal concerns that should be read in its entirety. The final Panelist draws attention to the need to illustrate the consequences of potential trade-offs.

○ Recommendations to address issue

Investigate how to fill the gaps in the National Estuarine Assessment

Examine the potential for changes in budget allocations to better invest in ecosystem science.

Find ways demonstrate the benefits of making explicit ecosystem trade-offs.

Conclusions

This OST MED review leaves no doubt that the ecosystem science programs are excellent examples of how headquarters programs can coordinate and support the work at the regional level. Ecosystem science programs like IEA, Climate and FATE do remarkable jobs of working across NMFS and NOAA to leverage resources and work products but more can be done. The programs are delivering on their objectives but Panel Members have pointed toward a need to more clearly identify the specific roles performed by OST MED programs in relationship to the overarching goals and to describe how the programs are connected for internal and external audiences. The difficulty in identifying the connections and roles served by OST MED programs leads to questioning whether the current structure is the best way to organize to lead and support ecosystem science for NMFS and NOAA. This is not to criticize the performance of the programs. Could OST MED be given more of an opportunity and resources to design and implement a more coherent composite ecosystem science program? NMFS and NOAA leadership is wholeheartedly committed to applying EBFM and EBM and OST MED is a major asset in this process.

Reviewer 1 Program Review of Ecosystem Science

Background

The panel reviewed the ecosystem science activities of the NOAA Fisheries Office of Science and Technology (OST). The presented activities included the Integrated Ecosystem Assessment (IEA) Program, the Fisheries and the Environment (FATE) Program, the Habitat Science Program, the Climate Program, the plankton database (COPEPOD), and ecosystem modeling coordination. All but one of these activities is housed within the OST Marine Ecosystems Division; the Habitat Science Program is housed within the Assessment and Monitoring Division. The panel also received information about the overall organization of OST, the relationship of OST to the regional Fisheries Science Centers (FSCs), and NOAA Fisheries efforts toward ecosystem-based fisheries management. The ecosystem activities of the FSCs were reviewed independently, so this review does not cover the ecosystem activities of NOAA Fisheries as a whole. Rather the review is limited to the ecosystem activities of OST and the OST interaction on ecosystem activities with the FSCs.

General Observations and Recommendation

The role of OST is to “lead and support the production, delivery, and use of ecosystem information to fulfill the agency’s mandates”. In doing so, the ecosystem programs (e.g., FATE) interact with one another as well as with the FSCs. OST ecosystem programs fulfill this role reasonably well and the programs appear to complement one another in general. Each program has a plan that describes objectives and priorities (e.g., IEA 3-year plan). There also is an OST Science Plan to describe overall objectives for ecosystem activities, with an overarching goal of “Lead and coordinate science support to national and regional programs engaged in assessment of living marine resources, including managed fish stocks, protected resources, and marine ecosystems and habitats.” While a strong general goal, this statement does not connect the individual programs. I recommend that an explicit description of these OST ecosystem programs be written, in particular describing where these programs separate and overlap. One descriptor that would help to differentiate programs is a list of the products (e.g., ecosystem status reports, climate science regional action plans) provided by each program. In addition, write goals and objectives that are more specific and that also support and demonstrate integration of OST ecosystem programs.

OST uses stock assessment funds (EASA), which have grown over the last several years, to support ecosystem programs (e.g., IEA). This is appropriate, because these funds are used to understand climate effects on fisheries and to inform fisheries managers. I recommend development of a strategy for determining the allocation to each individual program; this allocation is a key way for OST to influence and lead the direction and evolution of ecosystem activities within NOAA Fisheries.

Key (Specific) Findings and Recommendations

- Goals and objectives
 - o Observation: OST has a Science Plan with specific goals; these goals are derived from NOAA policies such as the National Ocean Policy, recognize major legal mandates such as the Magnuson-Stevens Fisheries Conservation and Management Act, and acknowledge the roles of OST and the FSCs. The ecosystem-related goal is general: “Lead and coordinate science support to national and regional programs engaged in assessment of living marine resources, including managed fish stocks, protected resources, and marine ecosystems and habitats.” In addition, each of the ecosystem programs have planning documents that describe specific program objectives (FATE: Program Implementation Plan and annual RFP; IEA: 3-year plan; Habitat: Habitat Assessment Improvement Plan (HAIP) and annual RFP; Climate: NOAA Fisheries Climate Science Strategy and Regional Action Plans). While the OST goal is a strong general goal, it does not connect the individual programs. In addition, the individual program objectives often are broad, thus masking differences among the programs.
 - o Recommendation to address issue: I recommend that an explicit description of OST ecosystem programs be written, with goals and objectives that are more specific and that also support and demonstrate integration of OST ecosystem programs. One descriptor that would help is a list of the products (e.g., ecosystem status reports, climate science regional action plans) provided by each program. In addition, consider updating the HAIP, which was published in 2010 and may be out of date.

- Integration with relevant programs
 - o Observation: These programs would better advance NMFS priorities if how they worked together were better described. For example, at the Ecosystem Science web page, each program (e.g., IEA, FATE, etc.) is individually identified. However there is no overarching statement describing how these programs are integrated. Areas of overlap and distinctiveness should be clearly identified. Some kind of document, maybe a two-pager, maybe not as elaborate as a Science Plan, would help.
 - o Recommendation to address issue: Document and disseminate how the programs work together (two-pager, web page). Clearly identify the research products of each program (e.g., ecosystem status reports, ecosystem models) that are produced by the FSCs. My sense is that while program goals overlap, these types of products differ among programs, and thus are a way to distinguish programs.
 - o Observation: The RFPs for each program, and the funds allocated by each program through working group decisions (the working groups affiliated with each program), are major ways for OST to influence the research direction of the FSCs. While the ecosystem programs are differentiated, there also are major overlaps. Further, ecosystem science built through integration and thus some research proposals may overlap more than one RFP. There is no place to submit an integrated project, because of the separation into individual programs. While OST staff work together and look for collaborations, there are some additional specific ways that integration could be promoted.
 - o Recommendation to address issue: First, add a statement to all RFPs that proposals jointly funded by multiple programs (e.g., FATE, stock assessment) will be considered. Second, have a common calendar date for the deadline for all OST RFPs. Third, annually convene the managers of each program to review the draft RFPs for each program (if not done already) and consider revisions, as necessary.
- Address priority needs
 - o Observations: As described in my goals response, each ecosystem program has planning documents that describe specific program goals and also research priorities. These priorities are updated, usually annually, by program working groups composed of members from the FSCs, OST, and sometimes other line offices. The members from the FSCs bring forward regional priorities that are addressed and consolidated into the RFP priorities.
 - o Recommendation to address issue: This is a reasonable approach for handling identification of priorities within each program and for receiving regional input.
 - o Observation: OST uses stock assessment funds (EASA), which have grown over the last several years, to support ecosystem programs (e.g., IEA). This is appropriate, because these funds are used to understand climate effects on fisheries and to inform fisheries managers. Given tight budgets and the high priority of stock assessment activities, the process used to decide these amounts is understandable (e.g., if money is leftover after ship days are funded).
 - o Recommendation to address issue: However describing the strategy for determining this threshold, as well as the allocation among ecosystem programs, would be useful. In particular, there should be a strategy for allocating among ecosystem programs. This allocation is a key way for OST to influence and lead the direction and evolution of ecosystem activities within NOAA Fisheries.
- Communication of status and accomplishments
 - o Observations: Each ecosystem program showed examples of how their program communicates their status and accomplishments, most of which are communicated regionally. Some examples: The IEA program showed examples of working with an SSC to expand integration of ecosystem components into Gulf of Mexico stock assessments, with a Council to adopt ecosystem indicators for California Current ecosystem, and through support of Fishery Ecosystem Plans in Alaska and West Coast. These efforts also are communicated through Ecosystem Status Reports, both web-based and brochures. The Habitat Program described two cases where habitat information was incorporated into stock assessments (northeast butterfish and West Coast groundfish). The Climate Program described the Climate Vulnerability Assessments, which include a summary of vulnerability by species that is used by managers and social scientists, as well as OceanAdapt, which provides a web-based tool to communicate and provide information on species distributions nation-wide.
 - o Recommendations to address issue: The regional dissemination of these products is appropriate given that most products are built regionally. However OST should expand their communication by adding these examples to the web sites for each program, as well as for the Marine Ecosystems Division as a whole (e.g., a button labeled "Program Products").

- Other
 - o Two states, Alaska and Hawaii, and something like half of US coastline, are missing from the National Estuarine Assessment. This is a large gap.
 - o A modeling coordinator recently was hired by OST for modeling coordination among FSCs. This seems like a reasonable approach to promote development of ecosystem models nationally. OST appropriately balanced model development and operation at the FSCs and model coordination at OST.
 - o The Habitat RFP is small (\$500K), yet there is substantial overhead to hold the RFP (reviewer time, working group time, OST staff time). I recommend discontinuing this separate RFP. Alternatively, consolidate administration of this RFP with another OST RFP, still directing \$500K to habitat research; distribute the \$500K evenly among the FSCs for habitat research; or remove the habitat label from the funds and add the \$500K to another ecosystem program.

Conclusions

The presenters provided clear descriptions of the OST ecosystem activities and had a well-developed sense of direction and purpose for these activities. The presentations covered a lot of ground and provided a good sense of the work done. Thank you for the opportunity to learn about your programs and provide comments, which I hope you find constructive and useful.

Reviewer 2: Program Review of Ecosystem Science

Background

National Marine Fisheries Service (NMFS) reviews are being conducted in 2016 to evaluate the ecosystem-related scientific programs that provide information relative to the management, protection and restoration of resilient and productive ecosystems. This review was focused on 6 programs run out of the Office of Science and Technology (OST) in Silver Spring, MD: Integrated Ecosystem Assessments (IEA), Fisheries Oceanography (FATE), Habitat Science, Marine Ecosystems and Climate, Global Plankton Database (COPEPOD), and Ecosystem Modeling Coordination. These programs control \$5-6M in resources to help develop national strategic and implementation plans, develop budget initiatives, and support efforts to coordinate and implement science activities to identify and address critical marine ecosystem topics.

General Observations and Recommendation

This review only directly addressed a very small component of the overall marine ecosystem efforts within NMFS, but the programs we reviewed are supposed to be coordinating the regional efforts and developing a national perspective. All of the programs are very productive and provide critical information for meeting NOAA's mission. These programs should be commended for their excellence and for providing the research that will move fisheries management into a more productive and effective future.

It was clear from the presentations and the documents provided that there is a lot of overlap between the different programs we were asked to evaluate. The programs do communicate with each other to minimize duplicated efforts and prevent double funding of research, but most programs lacked clear definitions of their research boundaries that may spill over into another program's area. It would help advance and focus all of the programs if the OST Office and the Science Centers were to develop an overall strategy for the collective marine ecosystem efforts. This strategy should connect and explain the relationships between the various programs and provide clear guidance and boundaries for moving all these programs forward. Providing an overall strategy would not only help the programs to better coordinate and complement each other, but would also help the larger community to know who to approach with proposals and future research ideas. An overall strategy would likely help with developing funding priorities within OST, the Science Centers, NMFS, and NOAA (e.g. better justifying budget initiatives).

All of the programs we reviewed are highly leveraging their funds to generate critical products well beyond what could be expected from the \$5-6M annual funding levels. The programs must continue to work closely with the Science Centers to align priorities and ensure that everyone is moving in the same direction. This does not mean that all regions need to be standardized. Each region has a unique set of challenges and issues, but the OST programs are critical for ensuring continuity across the regions where appropriate and allowing the regional efforts to learn from the successes and failures of the other regions. This is particularly important for marine ecosystem science as NMFS moves toward ecosystem-based management to deliver the information and services needed to achieve its mission.

One component of ecosystem based management that did not seem to be well represented in the marine ecosystem presentations was the incorporation of human dimensions studies. The IEA program did mention that they are working to develop conceptual models of the socio-ecological system, but overall the programs seemed to have minimal social science components in their portfolios. Given the connections to the fishing and marine industries and the importance of demonstrating the socio-economic benefits of the ecosystem-based management approach, it would seem important to strengthen the human dimension components of the research portfolios.

Finally, I would like to commend all of the programs for working across the line offices and with the larger scientific community to take advantage of related research in meeting the needs of the marine ecosystem goals. It is very easy to only look within your own organization and limit the scope of your program to the components that can be found internally. All of the programs identified important contributions from outside sources (e.g. OAR). I encourage the marine ecosystems programs to continue reaching out to scientists in other line offices to provide needed components that are not readily available within NMFS.

Individual Program Findings and Recommendations

1. Key Findings and Recommendations for IEA

- Goals and objectives
 - o Observations
 - The IEA Program seems to have a good strong vision of what it wants to be.
 - However, it seems to suffer from a lack of clear guidance, definition and promotion at the national level.
 - There was discussion over whether IEA is a thing or a process. This confusion can hamper the program's ability to achieve its goals.
 - o Recommendations to address issue
 - The OST office needs to better define its ecosystem program and how IEA fits into it.
 - A clear definition of what an IEA is needs to be determined.
- Integration with relevant programs
 - o Observations
 - IEA by its nature cuts across all aspects of ecosystem science and therefore potentially overlaps with all of the other programs.
 - It seems to work closely with the science centers and other ecosystem programs, but there still seems to be some confusion over who does what.
 - Given the unclear boundaries between programs, I can only imagine the potential confusion from those on the outside looking in.
 - o Recommendations to address issue
 - The OST office needs to better define its Marine Ecosystem Division objectives/goals and how IEA fits into them. What is IEA's niche relative to the other programs within the division?
- Address priority needs
 - o Observations
 - Despite the limited budget and unclear boundaries, the program gets an amazing amount of work done.
 - They have energized new ways of thinking about how NMFS meets its mission and is focused on the future.
 - They get a tremendous amount of leveraging from the Science Centers.
 - They primarily fund the synthesis and interpretation of the observations and science conducted outside this specific program making it very dependent on work that they do not directly control.
 - o Recommendations to address issue
 - I have no major concerns with their priorities other than clarifying what is part of IEA and what is not.
 - They operate on funds from multiple sources that are not necessarily secure (e.g. Assessment and Monitoring Division funding). It would be good to firm up and commit at the OST level to an appropriate funding amount for this critical program.
- Communication of status and accomplishments
 - o Observations
 - IEA produces a number of reports and has a strong web presence (e.g. multi-year IEA work plan). They even have a brochure advertising what they do.
 - Despite their communication efforts, requests for "ecosystem" context is still more informational than operational (often driven by a "crisis" in the Councils).
 - It is difficult to track/trace research results into management.
 - o Recommendations to address issue
 - Continue to highlight success stories and demonstrate the benefits of integrated assessments. Develop clear messaging illustrating the benefits of IEA to keep the community moving toward a more integrated approach to meet the NOAA/NMFS mission.
 - Continue to work with the Management Councils to incorporate more ecosystem based management.

2. Key Findings and Recommendations for FATE

- Goals and objectives
 - o Observations
 - The clear goal of "developing and evaluating ecological and oceanographic indicators to be used to advance an ecosystem approach to management by improving stock assessments" is strong and clear.
 - The FATE priorities seem to overlap significantly with the climate and IEA programs.
 - o Recommendations to address issue

- FATE should work with the other programs and the OST leadership to better define the boundaries of its program relative to the other programs.
- Integration with relevant programs
 - Observations
 - One challenge is the lack of a complementary scientific program in the academic sector with the same goals and priorities as FATE.
 - Recommendations to address issue
 - The program should work with the academic community to develop the next generation GLOBEC or CAMEO project.
- Address priority needs
 - Observations
 - The approach of funding short-term (2yr) projects is quite different from IEA but has been effective over the years.
 - It is difficult to track the use of FATE funded research after the projects are done.
 - Recommendations to address issue
 - The FATE program should work with the OST Office and the Science Centers to document how FATE research is incorporated into the stock assessments and management decisions. This would help demonstrate the value of this program during budget negotiations.
- Communication of status and accomplishments
 - Observations
 - FATE maintains a website and frequently interacts with the media on high profile research results.
 - Recommendations to address issue
 - FATE may want to focus on better sharing their accomplishments within NMFS and ensuring that the results are meeting the needs of the other NMFS components.

3. Key Findings and Recommendations for Habitat Science

- Goals and objectives
 - Observations
 - The Habitat program clearly ties into the NMFS mandates and is a key component of ecosystem based management.
 - The program has a habitat assessment development plan, but it seems to be pretty old (current plan is from 2010). This likely predates some of the latest thinking on ecosystem science.
 - They have habitat focus areas to direct their efforts.
 - Recommendations to address issue
 - Update the habitat assessment improvement plan.
- Integration with relevant programs
 - Observations
 - They seem to be well connected with all the Science Centers and the regional offices.
 - They do not seem to be as well integrated with the other ecosystem programs.
 - They are not located within the Ecosystems Division.
 - Recommendations to address issue
 - Consider moving the Habitat Program under the Ecosystem Division.
- Address priority needs
 - Observations
 - The program is very narrow in scope.
 - It seems to be very focused on coastal habitats. They should not ignore open ocean habitats.
 - It is focused on fished species. They should not ignore the ESA listed species.
 - Recommendations to address issue
 - Carefully consider the habitat role in ecosystem science and the scope of the program while updating the habitat assessment improvement plan.
- Communication of status and accomplishments
 - Observations
 - The “Our Living Oceans: Habitat” publication is a significant achievement. Nice job.
 - There have been a number of habitat science meetings recently.
 - Recommendations to address issue
 - Focus on communicating the role of the habitat program within the larger ecosystems structure.

4. Key Findings and Recommendations for Climate

- Goals and objectives
 - Observations
 - Goals and objectives are clear, but strongly connected to priorities in other line offices.
 - The program is funding important work to examine how fish are responding to climate change and project possible future changes.
 - Recommendations to address issue
 - Continue to work closely with OAR and other lines doing climate research to minimize duplicated efforts and maximize leveraging.
- Integration with relevant programs
 - Observations
 - Climate is leveraging a tremendous amount of work in other lines and other programs.
 - There seems to be a lot of overlap with IEA and FATE priorities.
 - Recommendations to address issue
 - Clarify to the community the differences between the work that the Climate program is conducting and what the other ecosystem programs are doing within their programs.
- Address priority needs
 - Observations
 - The program has made great progress in implementing a regional program in the Bering Sea, but it needs to build on that model in other regions.
 - Recommendations to address issue
 - The program needs additional funds to implement comprehensive climate-ecosystem programs in regions beyond just the Bering Sea.
- Communication of status and accomplishments
 - Observations
 - They have done a great job of developing a climate science strategy and developing regional action plans.
 - They have provided important contributions to the national climate assessment.
 - Recommendations to address issue
 - They need to develop a strategy for how to actually implement those plans. They should continue to communicate their accomplishments to leadership and keep pushing for initiatives for additional funding as climate impacts will continue to become more significant with time.

5. Key Findings and Recommendations for COPEPOD

- Goals and objectives
 - Observations
 - The COPEPOD program is a bit of an anomaly in OST. It is not really a program but more of a project to develop a specific database with aspirations to also provide additional value added products building off the database.
 - COPEPOD is a tremendous resource for the NMFS scientists and for the community, but has the danger of quickly becoming out-of-date if it is not properly supported.
 - Recommendations to address issue
 - If there is no obvious “home” for COPEPOD within one of the existing programs, then the OST leadership should find a way of providing oversight (beyond this one-time review) that ensures that the project is meeting the needs of the user community.
- Integration with relevant programs
 - Observations
 - Since COPEPOD is more of a tool than a program, integration means that the tool is used by the appropriate researchers.
 - It does seem to be well known and used by the outside community, but is not heavily used within the science centers. This could be because of the fish focus of the centers and programs or because it has not been properly introduced.
 - Recommendations to address issue

- As NMFS moves toward a more holistic view of ecosystems, the plankton component should become more relevant. Todd should continue to work with the centers and programs to evolve his products to better meet their needs and help them to appreciate the value of what he is already offering.
- Address priority needs
 - Observations
 - COPEPOD appears to be a valuable resource for the plankton community, but is not fully appreciated by the fish community.
 - It is likely to become more relevant and appreciated as the fisheries scientists embrace the ecosystem based management approach.
 - Recommendations to address issue
 - COPEPOD needs to be aware of and respond to evolving ecosystem needs within OST.
- Communication of status and accomplishments
 - Observations
 - COPEPOD has a strong web presence and a good user base outside of NMFS
 - Recommendations to address issue
 - COPEPOD needs to better demonstrate the value and relevance of this database to the scientists and managers.

6. Key Findings and Recommendations for Modeling

- Goals and objectives
 - Observations
 - The modeling program is a single FTE with no program funds.
 - Howard is very new to OST and still seems to be developing the specific goals and objectives for this program other than the concept of developing a modeling toolbox.
 - Recommendations to address issue
 - Howard needs to learn from and emulate the successful practices of the other programs as he continues to develop his program.
- Integration with relevant programs
 - Observations
 - This program is a bit different from the other programs that have more of a scientific focus. The modeling program is more focused on a tool and can only be successful if it is used within the other programs.
 - Recommendations to address issue
 - I suggest that Howard develop a persistent steering committee like the other programs, with program and science center people, that can help ensure proper guidance to most benefit the other components of the marine ecosystem division.
- Address priority needs
 - Observations
 - Models are clearly important for meeting the NMFS mission.
 - A need for the development of a standardized approach for modeling across NMFS was highlighted at the first national ecosystem modeling workshop.
 - Recommendations to address issue
 - An initial set of priorities have been identified, but additional support will likely be necessary to accomplish these priorities.
- Communication of status and accomplishments
 - Observations
 - Effective communications are the key to the success of this young program.
 - The program evolved from a series of ecosystem modeling workshops and reports so its status should be well documented. It will be important to continue to communicate the goals and milestones for this program as it evolves.
 - Recommendations to address issue
 - A workshop to introduce the program and receive input on how to prioritize actions may be necessary to get the needed buy-in.

Conclusions

The NMFS OST ecosystem programs are an excellent example of how headquarters programs can coordinate and enhance work conducted in the field offices. They provide a common framework that ties the regional marine ecosystem research efforts together and help develop critical products to enhance the NMFS goals. This can be complicated and difficult work, but all of the program representatives demonstrated a clear dedication to their work and a well-deserved pride in what they had accomplished. I appreciate the time that all of the speakers put into preparing for the review and their patience in answering our questions over three days.

Reviewer 3: Program Review of Ecosystem Science

Background

This individual review contributes to the panel review of the scientific programmes of OST that are directed to provide information relative to the management, protection and restoration of resilient and productive ecosystems. These programmes are mostly under the Marine Ecosystem Division. Ecosystem related science programmes are defined as those that elucidate ecological, oceanographic, climate and habitat related processes as they are related to living marine resources. This includes integrated ecosystem assessments and thus social and economic research that feeds into ecosystem oriented investigations.

General Observations and Recommendation

The Marine Ecosystem Division broadly covers the ecosystem priorities for OST. The review panel was provided information that primarily focused on ecosystem based fisheries management (EBF) but contributions to ecosystem based management (EBM) were also included in the information. The review panel was provided information on the following activities/programmes:

- Integrated Ecosystem Assessments (IEA)
- Marine Ecosystems and Climate
- Fisheries Oceanography (FATE)
- Global Plankton Database (COPEPOD)
- Habitat Science
- Ecosystem Modelling Coordination

I will consider the ST programmes on ecosystem to account for EBFM and EBM, as the remit of the review was on the science “*relative to the management, protection and restoration of resilient and productive ecosystems*”. This includes the human dimension. There appears to be an apparent tension between EBFM and EBM priorities in some of the programmes and within the division. I will also briefly consider some elements of ecosystem science that are not core to OST marine ecosystem division.

I would like to thank all of the participants and presenters in the workshop. Their messages were clear and all of them illustrated a dedication to their work and programmes.

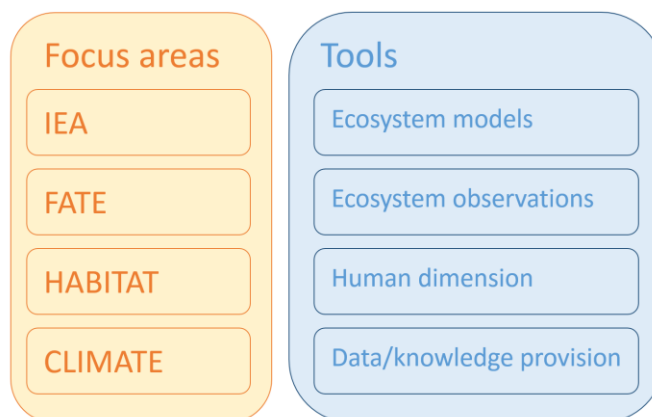
I received some personal reports back from the regional ecosystem reviews, suggesting that in some centers, researchers on the ecosystem issues feel that they are seen as “add on” to the more important “proper” fisheries research.

The formal reports from the centers to OST (survey responses) showed differing impressions about the OST role in the facilitation and stewardship of the science for ecosystem considerations. It appears that there is no common understanding of the role of OST in the process. I was surprised by the lack of ambition in the responses from the regional science centers about future developments and needs. It was interesting to see the absence of the phrase “trade-off” in their replies. Generally, I missed considerations on biodiversity, the physical impacts from fishing activities, marine sanctuaries, food web structure and function and ecosystem resilience in their responses, even though these issues are integral to the five priority documents. Some of the NMFS leadership team suggested this might be because these issues are seen as the responsibilities of the regional science centres. I was left with an impression that the science and knowledge provision for ecosystem considerations is not seen as a central component of the NMFS operations by many in the system.

The role of OST in facilitating national meetings (e.g., F2F for IEA, NEMoW for modelling) is important. These meetings are of great benefit to the researchers involved, and enabling progress towards ST objectives.

I will divide my initial consideration of the programmes on the basis of 1) focus areas and 2) tools. To aid the narrative of this review, I have added some other necessary tools. The COPEPOD database is considered to be part

of ecosystem observations and data/knowledge provision. Whilst, there are many overlaps between the focus areas, it was clear during the review that each of the focus areas plays a different role in the ecosystem work of OST. The responses from the fisheries science centers suggest that the conceptual distinction between CLIMATE, IEA and FATE is not so clear to many researchers. However, I had the feeling that the distinction was clear to the review panel.



Focus area - IEA

IEA is an overall approach to providing operational delivery of both EBFM and EBM. IEA is about ways to develop and provide knowledge and enable trade-off discussions. The aim to deliver both EBFM and EBM appears to have not have been fully reconciled within OST and NMFS. The mandate and role of NMFS working across agency is not fully clear, but NMFS taking on this role is to be supported. Whilst resourcing is inadequate, OST attempts to bring additional funding through additional lines. This is to be welcomed. The approach within the programme to focus on core capacity building and strategic projects makes sense. There still appears to be a lack of clarity about the IEA process across NMFS centers, and issues of NMFS leading NOAA efforts (especially in terms of joint funding).

Focus area - FATE

A strong applied science base is the key to the successful management of any living resource and the impact of exploitation on the ecosystem and human communities. FATE is aimed at providing the resources for research into fisheries oceanography and includes some IEA and climate research. FATE should be careful however not to oversell its potential. Research of this nature does have an exploratory element. It was impressive that FATE maintains clear records of application of science into management processes. FATE should consider in more detail its role in knowledge transfer and the need for co-creation of knowledge when providing knowledge for management. I would recommend some proportion of FATE be specifically targeted at the challenges of knowledge transfer to management.

Focus area - HABITAT

This programme appears to be very mature. It has a strong coastal and EFH orientation. It appears to provide many science products direct to policy and be linked to the office of habitat conservation. If further areas were to be considered, I would encourage research under this programme on deep sea habitats, developing activities (such as energy and mining) and mapping the national impact of various marine activities.

Focus area - Climate

This programme appeared to be very ecosystem oriented. There seemed to be little input into the social and economic side of the challenges of climate change to fishing communities. The recent EBFM policy “*recognizes the physical, biological, economic, and social interactions among the affected fishery-related components of the ecosystem, including humans; and seeks to optimize benefits among a diverse set of societal goals.*” I would

encourage CLIMATE to consider the issues of adaption and mitigation of communities to CLIMATE, in addition to research on the shifts in distribution and productivity of exploited species. I would expect CLIMATE to further intensify its management strategy and future scenario elements. By this, I do not mean predicting the future but about exploring the likely repercussions of current management actions. The vulnerability analysis and the development of regional plans are welcomed. I understand the need to support activities in what are perceived as priority regions, but I am not so convinced that only the northern centers are priority. Climate is a good example of building knowledge by using cross NOAA expertise.

Tools - Ecosystem Models

The appointment of an FTE to work within OST on ecosystem modelling is a welcome development. This shows the commitment of ST to providing tools and support to the centers. When models are used to provide advice, or to illustrate trade-offs between potential management options, it is important that stakeholders play some degree of role in the development of models. This should be considered more carefully during the development of the toolbox of ecosystem models.

Tools - Ecosystem Observations

Almost all of NFMS and OST ecosystem observations were outside the remit of this review. This is a crucial part of building the foundations for the “observe, assess, act and adapt” cycle of EBM. OST is aware of this. Further developments of the ST approach for ecosystems should consider the role that national guidance plays for observations and the collection of empirical information (surveys, remote sensing, port sampling etc.) when implementing the ecosystem approach. This includes the need to gain further insights in the functioning and processes within the ecosystem.

Tools - Human Dimension

Human dimension (social, economic, traditional and cultural issues) was largely absent from this review. This may reflect that other than IEA, the main focus areas (programmes) are very animal/biological habitat oriented. The review in 2017 on social and economic analysis will cover this area, but greater evidence of the inclusion of the human dimension and EBFM/EBM by OST should have been presented. It was important to bound the review and limit its remit, but the absence of any notable input from the human dimension may reflect that within OST, the ecosystem approach is differently perceived from that described in the EBFM policy.

Tools - Data/knowledge provision

Collecting the data and building up the knowledge base is only the first step. To effectively develop an ecosystem approach that is considered credible and legitimate by society, the data must be fully accessible, of known provenance, with auditable trails. To be effective, the data should be easily interchangeable and translate between platforms. Knowledge building should be a collaborative process and consider issues like trust. These previous statements are utopian, but should be included in objectives for facilitating the ecosystem approach. Much of the work of OST in this field was not included in the review, but it was touched on in IEA and FATE. The COPEPOD database also contributes to this tool. COPEPOD offers easy access to a diverse array of zooplankton databases. OST should strive to ensure that COPEPOD remains relevant, this will require COPEPOD to stay current to GIS, remote sensing, DOI, web based services etc. standards and developments.

Key Findings and Recommendations

- **Goals and objectives**

- Observations

The priorities and objectives for ecosystem oriented research through OST is formalized in five documents/initiatives:

- EBFM Policy/Road Map
- NOAA Fisheries Climate Science Strategy – RAPs

- Habitat Assessment Improvement Plan
- Multi-year IEA work plan
- Stock Assessment Improvement Plan update

Overall, these provide a broad range of information of what NMFS sees as key approaches and objectives for the role of ecosystem considerations and research within their mandate. It is a challenge however to reconcile the priorities between plans, and ensure that the national NMFS vision remains overall consistent and yet acknowledging the diversity of foci stemming from the regional approaches that feed the process. Tension between national and regional approaches is to be expected, and the ecosystem work should deliver products that solve regional challenges and provide the nation with resilient and productive ecosystems.

The five documents providing the priorities and objectives all have different status. The overall objective of the marine ecosystem division was not defined. The differences between the programmes within the division (or shared with others) was explained well to the review panel. However the regional science centers reported confusion between the overlapping objectives, and problems when applying for funding caused by this uncertainty. The development of the EBFM policy and climate science strategy is welcomed. The goals in terms of the human dimension to ecosystem approach in OST are not clearly iterated.

- Recommendations to address issue

A broader overarching priority and objectives document be produced. This document should be constructed in such a manner that it covers the science for EBM and EBFM and includes the human dimension. The challenge of cross-agency knowledge development should be addressed.

The document should also provide clarity on the relevant motives for each programme. I would recommend maintaining separate programmes as their roles appear distinct in my mind (but see other comments below). My interpretation is IEA is a framework for making EBM operational which enriches regional applications; CLIMATE and FATE facilitate applied research, HABITAT fulfils policy objectives. I recommend to OST that some formulation/framework be developed that distinguishes these roles (see below) and provides distinctions that are easily communicable.

- **Integration with relevant programs**

- Observations

In terms of day to day communication, it appears that the OST programme officers interact greatly. Evidence was provided that all programmes are aware of the need for integration and cross fertilisation of efforts with minimum replication. Evidence of integration with OST Economics and Social Analysis was not presented. Likewise the role of data provision within EBM was also not highlighted.

The regular national programme meetings proved to be effective for interactions between science centers and OST on specific focus areas.

- Recommendations to address issue

There should be increased integration with the human dimension and possibly the science information elements of ST is provide credible and effective leadership.

- **Address priority needs for current and future (5-10 years)**

- Observations

A large amount of key marine ecosystem science is being facilitated by OST. The priority activities are focused and delivering in those areas.

I do not think that the existing programmes are centred on delivering the climate strategy or the EBFM policy. The distinctive different roles of the programmes (some facilitating research, some policy driven, and some developing operational approaches) leads me to question whether an innovative re-aligning within the division would be beneficial. Above I distinguished between focus areas and tools. Many of the tools are outside the division, thus integration of ecosystem issues with other divisions is important. However, I feel that the main attention should be on how the focus areas operate and how to deal with new upcoming priorities and the delivery of existing plans.

Limited discussion occurred during the review on the cross over between science for living resource management and science for conservation policy. These fields appeared to be treated separately, although the overlap will likely increase in the future.

Little consideration of biodiversity and ecosystem function (beyond fish) elements was presented to the review despite being present across the five priority documents.

Other parts of the world are beginning to define what they mean by a healthy, or good marine environment. There may be an increase in calls for the US to also better define the objectives for the marine ecosystem state and suitable levels of anthropogenic pressure.

As IEAs increase in relevance and use, the need for understanding cumulative effects of multiple pressures, and spatial mapping will increase.

- Recommendations to address issue

How the programmes will facilitate the delivery of climate strategy and EBFM policy needs to be addressed. I am too detached from the operational constraints of the ST structures to recommend specific changes to the way that the programmes are envisioned within the division. So I recommend that some introspection takes place within OST jointly with the Science Board about how the activities within this division be aligned.

Regular reviewing of priorities and foresight exercises. Not only using insights from scientists, but from a broader range of stakeholders. Suggest a 6 year cycle of priority setting.

- **Communication of status and accomplishments**

- Observations

The distinct roles and responsibilities of the programmes are not communicated clearly to the community of NMFS researchers.

My overall impression is that OST does not appropriately communicate status and accomplishments of national ecosystem-based science programs to NMFS partners, stakeholders, the public, and NOAA and NMFS leadership. This is based on conversations and survey of the fishery science centers' replies.

I would expect OST to be a champion for ecosystem activities across the network. I am not convinced that this is how it is perceived.

- Recommendations to address issue

Any re-alignment of the programmes should consider carefully how the programmes are perceived outside OST. Changes should not just be about function, but about translation of purpose as well.

Communication approaches will never be good enough to address all constituencies. OST should accept that communication will always be a challenge and strive to constantly improve.

- **Other**

- Observations

Incorporating more ecosystem into the knowledge for management/policy process is not just about increasing certainty, improving financial rewards or addressing NGO concerns. It is about providing the knowledge for illustrating explicitly the consequences of potential trade-offs. OST should highlight even more the value of this concept.

With regards to the RFP, a mechanism needs to be found that could formally enable shared projects across programmes. The distinction between the programmes needs to be further communicated to the fisheries science centers. I would advise against creating one all-encompassing ecosystem programme, as focus on specific elements would be weakened.

- Recommendations to address issue

Increase the prominence of the benefits of providing explicit trade-offs.

Consider how the RFPs operate.

Conclusions

The programmes are delivering their objectives, but I am not convinced that the current programme set up is the most effective. There are issues related to the communication of programme roles, and how the programmes will deliver the objectives of the division and the wider OST contribution to the NMFS ecosystem science needs. I am not sure that the NMFS contribution to the wider NOAA efforts on EBM has been fully reconciled.

The division of marine ecosystems should consider the construction of a document that highlights objectives and priorities. The aim would be to bring the existing five priorities documents together. The way that the programmes (or additional programmes) will deliver the EBFM policy and climate strategy needs to be conveyed. A re-alignment might be necessary. The human dimension of the ecosystem approach needs to be better integrated.

I have no doubt in the NMFS science leadership's commitment to developing and applying the knowledge base for the ecosystem approach. OST is a major tool in this process, and should be seen as a champion that enables progress at the national scale.

Reviewer 4: Program Review of Ecosystem Science

Background

The charge to the review panel is to evaluate the current scientific programs of the NMFS Office of Science and Technology (OST) that are directed to provide information relative to the management, protection and restoration of resilient and productive ecosystems. Ecosystem-related science programs were defined as those elucidating ecological, oceanographic, climate and habitat related processes as they are related to living marine resource (LMR) species. In addition, the review should assess the extent to which current science programs are focused on the priority information needs required to complete the NMFS mission. Specifically for this review, the panel was presented principally with six ecosystem science programs that are centrally coordinated out of OST; e.g., the 'Integrated Ecosystem Assessments' (IEA) Program, the 'Fisheries and the Environment' (FATE) Program, the 'Habitat Science' Program, the 'Climate' Program, the 'Coastal & Oceanic Plankton Ecology, Production, and Observation Database' (COPEPOD)' Program, and 'Ecosystem Modeling Coordination'.

The review terms of reference articulated that while there are other habitat and climate-related programs within NMFS and NOAA, the focus of the review would be to provide advice on the direction and quality of the science programs that are conducted specifically in OST's "ecosystem science programs" such as those identified above. These programs are tasked to "lead" and "support" those interests with the NMFS six regional science centers (SCs) and serve as the interface between other NOAA components and interested parties. This reviewer, however, felt that other OST programs also make considerable contributions to the ecosystem science enterprise; e.g., supporting research in the regions administered via RFP (internal funding opportunities), or coordination of direct appropriations SCs (e.g., Cooperative Research, socioeconomics, etc.). To this end, by request presentations that touched on programs across the broader OST were made to the panel on the last day for consideration in the review.

General Observations and Recommendation

The OST oversees the NMFS's scientific research and technology development activities. As such the role of OST and their programs is to lead, support, and coordinate across the country. In contrast the principal roles in the "field" are to conduct the science and research in accordance with regional priorities.

With the exception of the Habitat Science Program, all programs considered for this review fall under the OST's Marine Ecosystems Division. Some programs are clearly more matured; e.g., FATE and IEAs. Their goals, accomplishments, and program evolution were evident. Some thoughts specific to each program follows:

FATE: FATE is essentially a fisheries oceanography program and seems to overlap a bit with the other OST programs, particularly with "Climate". The program has invested in one federal FTE in each of the SCs and conducts an annual RFP. FATE is governed by a 12-person 'steering committee' that includes an oceanographer and a stock assessment scientist from each of the SCs. In many ways FATE seems to have functioned as a "think tank" for new projects that has brought fisheries oceanography forward. Some of the FATE projects included very early looks at habitat compression, movement of species distribution due to climate shifts, understand how large-scale climate signals like the Pacific Decadal Oscillation (PDO) may (or more importantly may not) influence stock and ecosystem dynamics, and how to introduce oceanography into a dynamic management process. Many FATE products integrate into the goals and objectives of the other programs; e.g., development of ecosystem indices to support status reports, IEAs, ecosystem models, etc. How the FATE projects align to regional SC priorities was a question left unresolved but this ensuring this alignment is highlighted as a recommended priority going forward.

IEAs: The IEA framework is built to implement EBM e.g., more than EBFM. The program should receive kudos for the integrated program construct; i.e., inclusive engagement from NMFS SCs, NOAA LOs and programs (e.g., NOS-ONMS, OCM, CRCP, NCCOS, NESDIS, etc.), and OST programs. As such, of the programs reviewed here, this program best leverages (e.g., fiscally) across partners (a necessary model for success in ecosystem assessments). This program is also alone in articulating the incorporation of societal application and benefits, especially with regards to human dimensions. The 'Ecosystem Status and Trends (or Ecosystem Considerations)' report is an excellent product that the program has championed and provides valuable information for a number of constituents. Going forward I envision the IEA program being closely integrated with analysis of 'trade-off' considerations and

with MSE considerations and exercises. I do think there needs to see an IEA brought to conclusion and demonstrate It's time to "finish" an IEA and show that this is a product, not just a process.

Climate : The national climate program was launched in 2004 (>10 yrs ago). Recently, the generation of the NOAA Fisheries' Climate Science Strategy and the current effort to develop Climate Science Regional Action Plans are big accomplishments for the program. There seems to be considerable overlap with the IEA & FATE programs, and all programs claim climate successes but lack true integration and coordination between programs – unless the same program staff are involved across the programs which appears often is the case. Science support for projects has focused on certain regions and exhibits considerable imbalance for a program that's been around >10 yrs. The 'Climate Vulnerability Assessments' is a great initiative and should prove useful for providing science advice for management and/or conservation.

Habitat Science: The Habitat Assessment Improvement Plan (HAIP) was published in 2010 and serves as the guiding document for the Habitat Science Program. The program conducts an annual RFP that has disbursed \$3.3M since 2010. Significant accomplishments include publishing the first comprehensive summary of national and regional habitat types and habitat utilization in "Our Living Oceans – Habitat" and convening several National Habitat Assessment Workshops (NHAW) and Symposia (e.g., Essential Fish Habitat) to coordinate national interests. Going forward, HAIP and the program(?) recommends a 3-yr rotation of regional support. I'd suggest having the regional support tied to focus areas; e.g., Habitat Blueprint focus areas, where resources can be leveraged. The habitat science program has its challenges. It doesn't seem well integrated with other "ecosystem science" programs in OST and seems to hold a lower priority relative to other programs in many of the Science Centers. The narrow scope (stock assessment 1-2 yr) of internal proposal funding limits progress/success.

Ecosystem Modeling: The Ecosystem Modeling program is a fairly new program whose function to coordinate modeling activities across the country is clearly needed and OST is the logical place for that to occur. I encourage the ecosystem modeling program to engage and coordinate closely with the IEA, FATE, and Climate programs where there seems a bit of redundancy. That being said, I also recommend OST to assess the need for a full program explicitly tasked with the modeling function. And finally, I wasn't clear with the role and function of the Senior Scientist for Ecosystems vs. OST regarding the agency's ecosystem modeling vision. Clarification of the relationship is encouraged.

COPEPOD: This program is a broadly recognized global database and embraced by the international zooplankton community. I understand that it has a long history and aside from the one FTE supporting the program, doesn't require many resources to support it. OST is the logical home for the program though it seems an odd offering for this review. I don't have recommendations for this program.

Reviewer Questions:

1. Does ST have *clear goals and objectives* for its ecosystem-related science programs? Are ST ecosystem programs appropriate to advance ecosystem science and management for NMFS? (appropriate topics, program structures, mechanisms and prioritization procedures)

The general answer is "yes". The programs articulated their goals and ties to management well (e.g., goal's connection to core programs, FATE). Legal mandates such as MSA, MMPA, ESA, etc.; national policies (e.g., National Ocean Policy), and planning docs (e.g., NMFS Priorities and Annual Guidance document, the OST Annual Guidance Memorandum and Strategic Science Plans, Ecosystem-based Fisheries Management (EBFM) Policy and Roadmap, NOAA Fisheries Climate Science Strategy, etc.) help define and set the goals and objectives for the agency as well as the ecosystem focused programs.

2. Are ST ecosystem-related science programs *appropriately integrated* with other relevant programs? Is ST adequately collaborating with NMFS Science Centers and other relevant offices and programs across NOAA?

Again, I'd say the answer is "yes". Most of the programs have steering committees with membership composed of scientists from each of the SCs. Through the NOAA Fisheries Science Board, across agency awareness and alignment with Regional Science Center priorities is achieved. But there remains a fair bit of overlap in programmatic goals between programs within OST (e.g., FATE-IEA-Climate), the broader NMFS, and across the NOAA Line Offices (LOs) most notably NOS. In the field NOAA Regional Collaboration could help coordinate common interests, possibly through workshops. I recommend OST take a more active role at the HQ level to advance cooperative efforts and collaboration across programs where these overlapping interests and goals are identified.

3. Do OST's ecosystem-related science programs provide information to *address the priority needs* of the Science Centers, NOAA managers, Fishery Management Councils and Commissions, and other partners for ecosystem-related information?

Keeping in mind that the OST programs 'lead' and 'support' the national ecosystem enterprise, the answer is "yes" and as expressed in my response for #1, these programs appear aligned with SC priorities. The IEA ecosystem status reports (ecosystem consideration chapters) and IEA-FATE indices inform the management partners. The information from the programs also contributes to the development of Fishery Ecosystem Plans (FEPs).

4. Does ST appropriately *communicate* status and accomplishments of national ecosystem-based science programs to NMFS partners, stakeholders, the public, and NOAA and NMFS leadership?

OST programs use a full suite of venues and vehicles to communicate their status and accomplishments; e.g. peer-reviewed and grey publications, social media, and mass media (e.g., climate events – the "blob"). The programs provide the NOAA Science Board and SC Directors with regular program status report-outs; the question is if the frequency enough. To the point raised in the FATE presentation, "... to articulate the application of fisheries oceanography ... [and] engage more completely in the stock assessment process ..." has there been a joint FATE session at the annual NSAW? I agree with the FATE program recommendation of yes, if not, it is time for that joint meeting and if there has been, maybe a more defined meeting may be called for.

The special issue of the journal Oceanography on "Fisheries Oceanography" was a coup and a highlight as are the ecosystem status reports that go a long ways to communicate the science to management and conservation.

5. Others

The availability of fiscal resources are a concern. In FY-16, a total of \$5.68 million were disbursed by the OST ecosystem programs (IEA, FATE, Habitat Science, and Marine Ecosystems & Climate). As a national program, more resources are clearly needed to realize success. In the current fiscal environment, however, this will be difficult (and unlikely) to realize. NMFS will need to make ecosystem science more of a priority than currently afforded. From Link's presentation, "EBFM is needed, and NMFS is committed to doing so ...". If the EBFM policy and implementation plan (roadmap) is a true national priority for NMFS, costs to tackle ecosystem sciences should be shared across agency programs; e.g., Offices of Sustainable Fisheries, Protected Resources, and Habitat Conservation.

There are 77 total OST staff and 55 contractors of which 7 individuals are permanent FTEs in Ecosystem programs. Budget-wise, OST manages about \$91 million, of which \$49M transferred out. In this light, the logical recommendation would be to say that more resources need to put towards the ecosystem science programs however, there is concern over program growth; e.g., HQ administration ("lead and support") vs.

field execution-“doing the science” (which has administrative costs as well). The NOAA Fisheries science enterprise needs to resolve this aspect of program prioritization.

The RFPs are small (dollar-wise) and [I personally sense] administratively inefficient. I recommend consideration (revisit?) of a consolidated RFP with focus areas; e.g., maybe something like the SK funding model that identifies focus themes that can alter prioritization of focus from year to year consideration.

Because the socioeconomics programs will be under review next year, social science aspects were by and large left off the agenda for this review (IEAs aside). Nevertheless, I feel that the human dimensions and community role in ecosystems is very important. As such, it was good to have a short overview of OST’s socioeconomics presented on the last day so I’m appreciative of that effort. The take home message from the brief was that the fiscal support for social sciences to conduct ecosystem science is very, very poor. So while again not intended for this review, I strongly recommend finding some flexibility in funding streams to support the social science programs for ecosystems science.

6. Conclusions

The OST ecosystem science programs reviewed here are intended to ‘lead’ and ‘support’ ecosystem science from the national perspective and with the regional SCs. For all of the programs, that’s a tall order and it’s very clear that the successes are fully attributable to an OST staff that is incredibly dedicated and who should be commended on a great job of juggling the tasks, flow of expectations, and maximizing outcomes with very limited resources. I thank the OST, the Leadership, and presenters for very informative presentations and for candid, quality conversations and information exchanges.

My recommendations are outlined in my capsules and response to questions above. Finally, it’s clear that if ecosystems science is where we as an agency need or want to go (in a zero sum world), hard decisions need to be made. I close with the following thought:

In Richard Merrick’s opening remarks, he asked us to consider:

“... are we doing the right science? Are we doing the right science well? ...”

I pose that NMFS as a science-based agency should ask themselves, “... are we doing ENOUGH science?”